Patent
Attorney's Docket No. 032287-021

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of	)	
	)	
Robert BALDEMAIR	)	Group Art Unit: Unknown
	)	
Application No.: 09/868,706	)	Examiner: Unassigned
	)	
Filed: June 20, 2001	)	
	)	
For: METHOD FOR TRANSMITTING DATA BLOCKS WITHOUT PREFIX IN THE GUARD INTERVAL, SAID DATA BLOCKS ARE DEMODULATED BY MEANS OF FFT WITH A LENGTH GREATER OR EQUAL THE SYMBOL PERIOD	)	

CLAIM FOR CONVENTION PRIORITY

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

The benefit of the filing date of the following prior foreign application in the following foreign country is hereby requested, and the right of priority provided in 35 U.S.C. § 119 is hereby claimed:

Austrian Patent Application No. A 2128/98

Filed: December 21, 1998

In support of this claim, enclosed is a certified copy of said prior foreign application together with the English translation thereof.. Said prior foreign application was referred to in the oath or declaration. Acknowledgment of receipt of the certified copy is requested.

Respectfully submitted,

BURNS, DOANE, SWECKER & MATHIS, L.L.P.

Date: September 25, 2001

By: _____
Kenneth B. Leffler
Registration No. 36,075

P.O. Box 1404
Alexandria, Virginia 22313-1404
(703) 836-6620

(03/01)

AUSTRIAN PATENT OFFICE
A-1014 Wien, Kohlmarkt 8 - 10

File Number: **A 2128/98**

The Austrian Patent Office certifies that

The firm Ericsson Austria Aktiengesellschaft
in A-1121 Wien, Pottendorfer Straße 25 - 27,

filed on **December 21, 1998** a patent application relating to

„Method of transmitting data"

and that the attached specification and drawing correspond to the original specification and drawing filed together with this patent application.

It was requested to cite Dipl.-Ing. Robert Baldemair, Vienna, as the inventor.

Austrian Patent Office
Vienna, May 10, 2001

The president

A2127/98-1 **Original text**

23405/we

(51) Int. Cl.:

Austrian Patent No.

(73) Patentee: Ericsson Austria Aktiengesellschaft Wien (AT)

(54) Subject matter: Method of transmitting data

(61) Addition to Patent No.:

(62) Continuation in part of:

(22) (21) filed on: 1998 12 21

(33) (32) (31) union priority:

(42) Start of the duration of the patent:

Longest possible duration:

(45) delivered on:

(72) Inventor:

(60) Dependency:

(56) References that were taken into consideration for assessing patentability.

The invention relates to a method of transmitting data by means of a multiple carrier method, e.g. DMT (Discrete Multitone) in a transmitter channel, in which the data are combined in a transmitter into a transmitter signal in the form of transmitter blocks with the same number M of information symbols, are modulated and transmitted by an Inverse Fast Fourier Transform (IFFT) of the transformation length M and are demodulated in a receiver by the Fast Fourier Transform (FFT), wherein, on the transmitter side, one guard interval for equalization on the side of the receiver is inserted each between the transmitter blocks and transmitted together with them, said guard interval having a length P that is greater than or equal to the memory length of the transmission channel, and wherein demodulation is carried out in the receiver by means of the Fast Fourier Transform (FFT) with a receiver transformation length L that is greater than or equal to the sum of the transformation length M and the length P of the guard interval.

Many of the known transmission methods use the available frequency range of a transmission channel by properly modulating the data to be transmitted. In frequency-division multiplexing, the frequency spectrum is divided into several slots through which information is transmitted. Such methods have become known under the designations multiple carrier method, Orthogonal Frequency Division Multiplex (OFDM) and Discrete Multitone Technique (DMT).

A predetermined, broad frequency band is thereby subdivided into a host of very narrow subchannels over which data are transmitted. For this purpose, the data are combined in a transmitter into information blocks of the same length and are modulated by an Inverse Fast Fourier Transform that effects a filtration of the subchannels with frequency-shifted versions of a prototype filter. The transmitter serially transfers the thereby generated transmitter block onto the transmission line. The memory of the dispersive transmission channel generally causes consecutive blocks on the receiver side to interfere. In order to avoid overlapping on the receiver side, a guard interval must be inserted between the discrete blocks on the transmitter side. Demodulation of the data occurs in the receiver by means of a Fast Fourier Transform (FFT), the input samples being transformed in blocks into spectral values. When using the FFT in the receiver, equalization can be considerably simplified by also transmitting in the guard interval a cyclical prefix consisting of a number of recurrent data from each block, said data being transmitted within the guard interval before the block with respect to time. The transformation length L of the FFT thereby equals the length M of the data blocks transmitted. In

order to obtain efficient equalization, the guard interval or the cyclical prefix respectively must be greater than or equal to the memory length of the channel. The advantage of the relatively easy equalization entails however the disadvantage of the data being transmitted in the prefix signal without any gain of information and requiring part of the transmitting power available for themselves.

In the OFDM method for radio transmission of data which is indicated in US Patent No. 5 357 502, the transmission of the information is carried out by means of N orthogonal carrier frequencies that are modulated by an Inverse Fast Fourier Transform. In order to avoid interferences between the discrete carrier frequencies, the time windows of these filters are not chosen to be rectangular like in the conventional OFDM methods, they are rather selected according to the Nyquist criterion. N data values at a time are thereby combined into information blocks according to the number of carrier frequencies. Figure 4 of this document shows the Nyquist interval used for transmitting, a guard interval in which a prefix with useless information is also transmitted being left free between the transmitter blocks.

Furthermore, EP 0 682 426 A discloses an OFDM transmission system with Fast Fourier Transform (FFT) and quadrature amplitude modulation (QAM), a pilot signal being transmitted together with a portion of the block of information in the guard interval of each block of information transmitted.

It is therefore the object of the invention to indicate a method of the type mentioned herein above that makes equalization of the transmitted transmitter signal on the receiver side possible without transmitting useless information at the same time, thus increasing the transmitting power available for data transmission.

This is achieved according to the invention in that the signal values of the transmitter signal contained in the guard interval have a signal amplitude of zero.

The advantage of the method according to the invention is that in the guard interval no signal or power needs to be transmitted, which entails that the mean transmitting power is thereby reduced, but that the equalization of the signal transmitted can be carried out with relatively little expenditure. Assuming a predetermined power density, it is therefore possible to increase the transmitting power for the blocks of information within a transmission channel.

According to an exemplary embodiment of the invention, demodulation may advantageously be conducted in segmenting the receiver signal in the receiver into blocks of the length M+P and in lengthening every single block by appending zeros to the receiver transformation length L.

In another embodiment of the invention there may be provided that the receiver transformation length L of the Fast Fourier Transform (FFT) equals the double transformation length 2.M.

According to still another embodiment of the invention there may be provided that the guard interval is transmitted each before or after a transmitter block.

The invention will be described more fully herein after with the help of the embodiment illustrated in the drawing.

Figure 1 shows a transmitter signal when using a cyclical prefix according to prior art;

Figure 2 shows the decomposition into blocks of the length M of a receiver signal generated by the transmitter signal according to Figure 1;

Figure 3 shows a prefix-free transmitter signal according to an embodiment of the method according to the invention;

Figure 4 shows the decomposition into blocks of the length M+P of a receiver signal generated by the transmitter signal according to Figure 3 and

Figure 5 shows the demodulation of the receiver signal according to Figure 4 by an FFT of the length 2M.

(Continued on page 3 of the original description)

International Patentapplication PCT/AT99/00311
Applicant: Telefoniesktiebolaget LM Ericsson et al.

NEW CLAIMS

Amended sheet

1. Method of transmitting data by a multiple carrier method, e.g. DMT (Discrete Multitone) in a transmission channel in which the data are combined in a transmitter into a transmitter signal in the form of transmitter blocks with the same number M of information symbols, are modulated and transmitted by an Inverse Fast Fourier Transform (IFFT) of the transformation length M and are demodulated in a receiver by the Fast Fourier Transform (FFT), wherein, on the transmitter side, one guard interval for equalization on the side of the receiver is inserted each between the transmitter blocks and transmitted together with them, said guard interval having a length P that is greater than or equal to the memory length of the transmission channel, and wherein demodulation is carried out in the receiver by means of the Fast Fourier Transform (FFT) with a receiver transformation length L that is greater than or equal to the sum of the transformation length M and the length P of the guard interval, **wherein** the signal values of the transmitter signal contained in the guard interval have a signal amplitude of zero.

2. Method according to claim 1, **wherein** the receiver signal is segmented in the receiver into blocks of the block length M+P and that each of these blocks is lengthened by appending zeros to the receiver transformation length L.

3. Method according to claim 1 or 2, **wherein** the receiver transformation length L of the Fast Fourier Transform (FFT) equals the double transformation length 2.M.

4. Method according to claim 1, 2 or 3, **wherein** the guard interval is transmitted each time before or after a transmitter block.

METHOD FOR TRANSMITTING DATA BLOCKS WITHOUT PREFIX IN THE GUARD INTERVAL, SAID DATA BLOCKS ARE DEMODULATED BY MEANS OF FFT WITH A LENGTH GREATER OR EQUAL THE SYMBOL PERIOD

The invention relates to a method of transmitting data by means of a multiple carrier method, e.g. DMT (Discrete Multitone) in a transmitter channel, in which the data are combined in a transmitter into blocks with the same number M of information symbols, are modulated and transmitted by an Inverse Fast Fourier Transform (IFFT) and are demodulated in a receiver by the Fast Fourier Transform (FFT), wherein, on the transmitter side, one guard interval for equalization on the side of the receiver is inserted each between the blocks and transmitted together with them, said guard interval having a length P that is greater than or equal to the memory length of the transmission channel.

Many of the known transmission methods use the available frequency range of a transmission channel by properly modulating the data to be transmitted. In frequency-division multiplexing, the frequency spectrum is divided into several slots through which information is transmitted. Such methods have become known under the designations multiple carrier method, Orthogonal Frequency Division Multiplex (OFDM) and Discrete Multitone Technique (DMT).

A predetermined, broad frequency band is thereby subdivided into a host of very narrow subchannels over which data are transmitted. For this purpose, the data are combined in a transmitter into information blocks of the same length and are modulated by an Inverse Fast Fourier Transform that effects a filtration of the subchannels with frequency-shifted versions of a prototype filter. The transmitter serially transfers the thereby generated transmitter block onto the transmission line. The memory of the dispersive transmission channel generally causes consecutive blocks on the receiver side to interfere. In order to avoid overlapping on the receiver side, a guard interval must be inserted between the discrete blocks on the transmitter side. Demodulation of the data occurs in the receiver by means of a Fast Fourier Transform (FFT), the input samples being transformed in blocks into spectral values. When using the FFT in the receiver, equalization can be considerably simplified by also transmitting in the guard interval a cyclical prefix consisting of a number of recurrent data from each block, said data being transmitted within the guard interval before the block with respect to time. The transformation length L of the FFT thereby equals the length M of the data blocks transmitted. In order to obtain efficient equalization, the guard interval or the cyclical prefix respectively must be greater than or equal to the memory length of the channel. The advantage of the relatively easy equalization entails however the disadvantage of the data being transmitted in the prefix signal without any gain of information and requiring part of the transmitting power available for themselves.

It is therefore the object of the invention to indicate a method of the type mentioned herein above that makes equalization of the transmitted transmitter signal on the receiver side possible without

transmitting useless information at the same time, thus increasing the transmitting power available for data transmission.

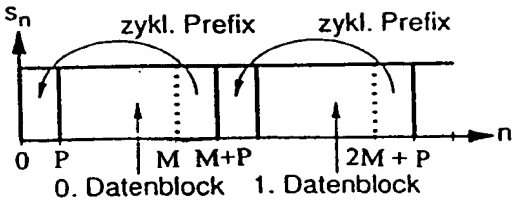

FIG. 1

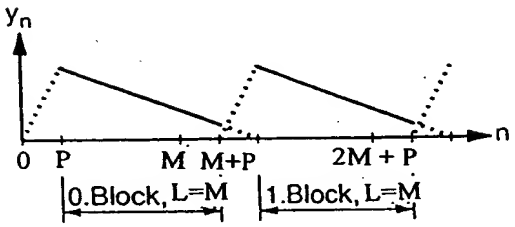

FIG. 2

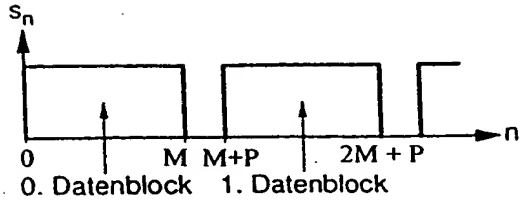

FIG. 3

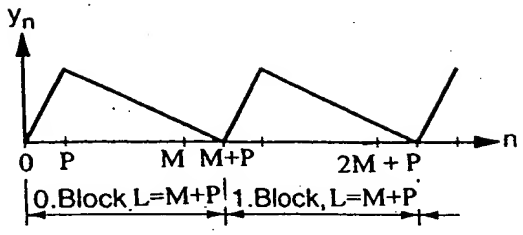
y_n
n
0
P
M
M+P
2M + P
0.Block L=M+P
1.Block, L=M+P

FIG.4

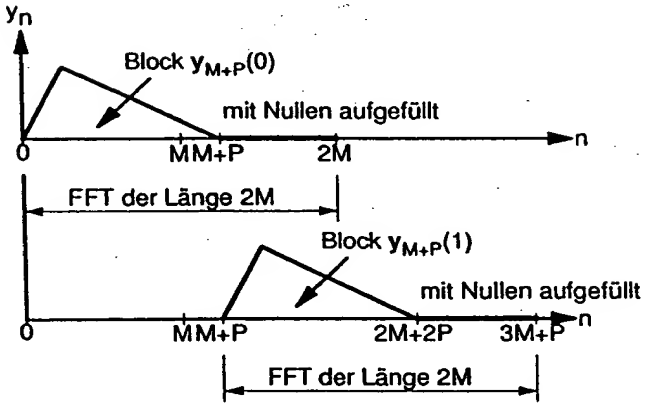
y_n
Block $y_{M+P}(0)$
mit Nullen aufgefüllt
n
0
MM+P
2M
FFT der Länge 2M
Block $y_{M+P}(1)$
mit Nullen aufgefüllt
n
0
MM+P
2M+2P
3M+P
FFT der Länge 2M

FIG.5